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VEHICLE IDENTIFICATION USING THE ACOUSTIC SENSOR: TRAINING, SENSING CONCEPTS, AND BANDWIDTH

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Experiments were designed (1) to develop and validate a training program for using the acoustic sensor to identify vehicles in convoy; (2) to provide estimates of operator performance in identifying vehicles using the acoustic sensor; and (3) to investigate the effect of different sensing concepts and bandwidths on the operator's ability to identify vehicles.

Following an orientation and procedure training, 18 school-trained, unattended ground sensor (UGS) operators were tested in their ability to

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identify military vehicles in convoys. Magnetic tape recordings simulated use of the acoustic remote sensor in the field. Two sensing concepts were incorporated--continuous, wherein the operator monitors the entire convoy, and intermittent, wherein the operator hears each vehicle in the convoy for 4 seconds.

Operators then received vehicle recognition training that used concepts of immediate feedback, self-scoring, paired comparisons, and practice. Following this training, the operators were retested to measure the effects of the training. An exploratory study compared operator performance using three bandwidths: 50-1500 cps, 50-2000 cps (presently used), and 50-4000 cps.

Operators varied widely in ability to identify individual vehicles in convoys. The best operator reported twice as many correct identifications as did the poorest operator, under some conditions.

The intermittent type of sensor was superior in vehicle identification to the continuous. Both are superior in information potential to the current operational sensor, the Audio Add-On Unit.

The training package substantially improved operator performance. Operator reports were evaluated using five levels of classification detail. In terms of exact vehicle identification, operator performance rose from 27% to 40%. When vehicles were categorized into light wheeled, heavy wheeled, APC's, and tanks, operator performance rose from 32% to 43%. When vehicles were categorized into wheeled vehicles, APC's, and tanks, operator performance rose from 53% to 67%. When vehicles were categorized into wheeled and tracked vehicles, operator performance rose from 68% to 78.5%. The exploratory study of bandwidth indicates that the 2000 cps is significantly better than the 1500 cps for vehicle identification. There is no significant difference in operator performance between 2000 cps and 4000 cps.

If field requirements permit, only those operators having good sound recognition ability (about the upper 50%) should monitor acoustic sensors. The training package should be sent to field units for periodic refresher training and used at USAICS for UGS training. The intermittent type of sensor was significantly better than the continuous, but both should be considered for use in REMBASS. The exploratory study on bandwidth indicates that the 50-2000-cps range currently used by the Army is adequate.

Technical Paper 334

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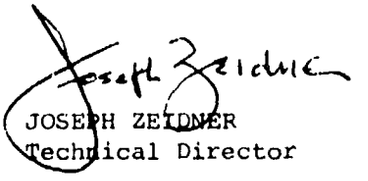
FOREWORD

The Battlefield Information Systems Technical Area of the Army Research Institute (ARI) is concerned with the demands of the future battlefield for increased man-machine complexity to acquire, transmit, process, disseminate, and utilize information. The research focuses on the interface problems and interactions within command and control centers and concerns such areas as topographic products and procedures, tactical symbology, information management, user-oriented systems, staff operations and procedures, and sensor systems integration and utilization.

Of special interest is the problem of human factors in the presentation and interpretation of surveillance and target acquisition information. One relatively new source of intelligence information is remote monitoring of the battlefield, using seismic, acoustic, and magnetic unattended ground sensors (UGS). When enemy personnel or vehicle movement activates these remote sensors, a monitor display located behind our lines indicates the activity. The operator can derive from this display not only the enemy's presence but also such information as direction and speed of convoys and personnel, number of vehicles in a convoy, and convoy composition--e.g., armored versus wheeled vehicles.

This publication concerns the development and validation of special training for the acoustic remote sensor--currently the best unattended ground sensor for identification of vehicles. In addition, two new sensing concepts were investigated for future use in new systems and found better than present-day concepts. Bandwidth requirements based on operator needs were experimentally defined.

Research on sensor systems integration and utilization is conducted both in-house and under contract, in response to requirements of Army Project 2Q763743A774 and to special requirements of the U.S. Army Intelligence Center and School, Fort Huachuca, Ariz.; Project AVID GUARDIAN, U.S. Army, Europe; and the Remotely Monitored Battlefield Sensor System Project (REMBASS). Special requirements are contained in Human Resource Needs 77-120 and 77-170.



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VEHICLE IDENTIFICATION USING THE ACOUSTIC SENSOR: TRAINING, SENSING CONCEPTS, AND BANDWIDTH

BRIEF

Requirement:

The experiments were designed to meet the following requirements: (a) to develop and validate a training program for using the acoustic sensor to identify vehicles in convoy; (b) to provide estimates of operator performance in identifying vehicles, using the acoustic sensor; and (c) to investigate the effect of different sensing concepts and bandwidth modifications on the operator's ability to identify vehicles.

Procedure:

Following orientation and procedure training, 18 school-trained operators of unattended ground sensors (UGS) were tested on their ability to identify military vehicles in convoys. Magnetic tape recordings simulating use of the acoustic remote sensor in the field were used. The taped simulation was developed from recordings collected in the field during maneuvers of armored and motorized infantry units. Incorporated in the test tapes in a counterbalanced arrangement were two acoustic sensing concepts, "continuous" and "intermittent." In the continuous mode, operators hear the entire convoy as it passes the microphone. In the intermittent mode, they hear each vehicle for a period of only 4 seconds, with 2 seconds of silence between each vehicle. Seven vehicle types were involved--jeeps, gamma goats, 2½-ton trucks, 5-ton trucks, 10-ton trucks, armored personnel carriers, and tanks.

The operators then received vehicle recognition training which used immediate feedback, self-scoring, paired comparisons, and practice. After the training, the operators were retested to measure its effects. An exploratory study was then conducted to compare operator performance when different bandwidths were used--50-1500 cycles per second (cps), 50-2000 cps (now in use), and 50-4000 cps.

Findings:

The training package developed increased operator vehicle identification performance by 46% to 16%, depending on the level of target detail required.

An increase of 6% to 10% in vehicle identification can be achieved by using the intermittent type of sensor rather than the continuous. A saving of 33% in battery life would also result. Either type of sensor has a greater information potential than the present-day Audio Add-On Unit.

An increase of 13% in vehicle identification can be achieved by using the top third of operators selected on their ability to interpret acoustic signals, as measured by the initial test in this exercise.

The 50-2000-cps bandwidth currently used by the Army for the remote sensor was better than 50-1500 and as good as 50-4000 cps for vehicle identification purposes.

Utilization of Findings:

The self-administrable training tape should be used at the U.S. Army Intelligence Center and School for UGS operator training and in field units for periodic refresher training.

Depending on field requirements, the remote sensor platoon leader should selectively assign operators on the basis of their capabilities. Both the intermittent type and the continuous type of sensor should be considered for use in the Remotely Monitored Battlefield Sensor System (REMBASS).

The bandwidth currently used by the Army for the acoustic remote sensor is adequate.

VEHICLE IDENTIFICATION USING THE ACOUSTIC SENSOR: TRAINING, SENSING CONCEPTS, AND BANDWIDTH

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VEHICLE IDENTIFICATION USING THE ACOUSTIC SENSOR: TRAINING, SENSING CONCEPTS, AND BANDWIDTH

INTRODUCTION

The Remotely Monitored Battlefield Sensor System (REMBASS) program is evidence of the Army's commitment to development of an advanced unattended ground sensor (UGS) system for the battlefield of the future. The acoustic sensor, among those now used by the Army, will play an important role in the future. With human interpretation, the acoustic sensor is the best target identification system currently in the UGS inventory. Although this sensor was originally developed for monitoring jungle trails, a promising application is the detailed monitoring of convoy activity in any theater of operations. The North American Treaty Organization's Avid Guardian program has recently completed a series of tests to investigate applications of acoustic sensors in monitoring convoys in Europe.

The current operational acoustic sensors are the audio add-on unit (AAU), the hand-emplaced commandable (HEC) microphone, and the commandable microphone (COMMIKE).[1] The AAU is a noncommandable sensor slaved to the MINISID III. The AAU transmits 15 seconds of audio after three seismic activations have occurred within a 28-second time period. There is a minimum 20-second dead period between the 15-second transmissions. During continuous target activity such as with a convoy, the 15-second transmission time is not long enough to listen to the whole convoy, and the 20-second dead period yields no information. Other things being equal, this dead time may cause a substantial loss of information concerning the composition of a convoy. The HEC is an acoustic sensor that will transmit audio for 1.25, 5, 10, or 20 seconds upon operator command. The audio transmission time is preset by programing the code plug. The air-dropped version of this sensor, the COMMIKE, uses parachute deployment for canopy hang-up.

Both the HEC and the COMMIKE offer more flexibility than the AAU, in that the audio transmission is under operator control. The disadvantage is that frequently the operator must command these sensors from a remote location, using the preset transmission time. Among the three, the AAU is the most widely used acoustic sensor in the Army today.

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[1] USA Unattended Ground Sensor Devices (ST-30-20-1). The United States Army Combat Surveillance and Electronic Warfare (USACSEW) School, Fort Huachuca, Ariz. Revised Edition, April 1973.

Research and development efforts to improve the capability of the acoustic sensor have been principally under the aegis of the REMBASS project.[2] In addition to including an advanced version of the AAU, REMBASS has been experimenting with putting more of the decisionmaking (analysis and classification) function of the UGS operator into engineering technology by using an acoustic spectrum analyzer to classify targets as either wheeled vehicles, tracked vehicles, or personnel.

Despite significant research and development expenditures to improve hardware capability, very little has been spent to upgrade the operator's analysis potential. The need for training to improve operator performance is recognized by many, including UGS field units, the United States Army Intelligence Center and School (USAICS), and Project Avid Guardian. Army personnel in the field have used acoustic sensors less extensively than seismic sensors because of many factors, including lack of equipment. Thus, once assigned to the field, operators typically do not have the opportunity to maintain or upgrade their skill levels. In addition, time restraints at the UGS school limit the amount of sound recognition training that can be provided.

Several approaches to new design concepts have been advanced to improve the potential for obtaining information by monitoring convoys. One such approach is to have the sensor provide continuous audio transmission as a convoy passes. Such a sensor is automatically turned on and off by a seismic sensor much as the AAU is now activated. A second approach is to have the sensor provide audio transmission for 4 seconds when each vehicle in the convoy is closest to the sensor. Such a sensor could be automatically triggered by a line sensor. Because the audio is transmitted intermittently, this method saves 33% of the battery life as compared to the continuous sensor. Both the continuous and intermittent sensors have the potential of providing 100% of available convoy information as opposed to the current AAU system, from which the information potential is only about 50%. If operators could distinguish between the vehicles in aggressor convoys and identify them, the field commander would have a significant improvement in his intelligence-gathering system.

The frequency range (bandwidth) of the signal transmission is another variation which may have an impact on operator performance and perhaps on sensor design. The acoustic sensor that REMBASS is developing uses the same frequency range--50-2000 cps--as does the AAU. A systematic operator performance test is needed to investigate the user (operator) requirements for bandwidth. A narrower band (50-1500 cps) may provide the same information, and a wider band (50-4000 cps) may provide increased information.

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[2] HQ, Department of the Army, REMBASS Specification-004, November 1975, pp. 1-8.

Specific Objectives

The experiments were conducted to (a) obtain an estimate of the current level of UGS operators' (MOS 17M) ability to identify individual vehicles traveling in convoys, (b) develop and validate a training program for improving the operators' ability to identify vehicles, (c) compare the continuous and intermittent sensor concepts, and (d) explore the relative effectiveness of three signal bandwidths--50-1500 cps, 50-2000 cps, and 50-4000 cps.

THE TRAINING PACKAGE

The training package was developed to familiarize the operators with the various vehicle sounds for both continuous and intermittent sensor types. Each of the two major sections, Continuous Sound Recognition Training and Intermittent Sound Recognition Training, was further divided into the following five parts.

Part I - Practice convoys with feedback
Part II - Paired comparison of all vehicles (fast speed)
Part III - Practice convoys with feedback
Part IV - Paired comparison of all vehicles (slow speed)
Part V - Repeat test of convoys 1, 2, 3, and 4 with self-scoring.

The complete training package is presented in Appendix A, Facilitator Guide. The entire sensor training program was recorded on tape and could be used as a self- or a group-administrable package. Training on the intermittent sensor was given first. Training on the two sensor types was generally similar. (Differences are noted where applicable.) For both types, Part I involved a short instructional briefing, followed by a two-convoy exercise in which the operators identified the vehicles. Feedback was provided to the operators by giving them the correct vehicle identification. The operators recorded the vehicle names on their target logs so that they could score their interpretations. In addition to motivating the operators, these scores were later used by the facilitators to check learning progress informally.

For the intermittent sensor, the operators analyzed the same convoys a second time, with immediate feedback to assist learning. This time they identified the vehicles mentally as they heard them, without filling in a target log, and were given the identity of the vehicle immediately after its presentation. After everyone understood this procedure, the convoys with feedback were replayed for additional practice.

In the case of the continuous sensor, this method could not be used. Instead, the operators were given the same convoys to analyze again as they observed their target logs with the correct identifications marked on them. As the convoys were replayed, a short tone signaled when each vehicle was at closest-point-of-approach (CPA) to the

sensor. This procedure was used in the continuous case to teach the operators to detect vehicles on the basis of variations in loudness. As with the intermittent sensor, the procedure was repeated for additional practice.

Part II for both sensor types involved a comparison of the sound of one vehicle with that of another immediately following. For each paired comparison, the vehicle identities were given before the sounds. Each of the target types (vehicles) was compared with every other target type for a total of 21 paired comparisons. One additional comparison was made involving an M60 tank and a Sheridan tank. All target vehicles were traveling in the fast condition--about 40 kilometers per hour (kmph) or 24 miles per hour (mph). This exercise was designed to help the operators remember how the vehicles sound in relation to one another.

Part III for both sensor types involved the same procedures as in Part I, except that two different convoys were used. This exercise gave the operators practice on the same vehicle types but with different individual vehicles and with different combinations and variations in signal/noise ratio and loudness.

Part IV for both sensor types involved the same matched-pairs procedure as Part II. However, the target vehicles were traveling slower than in Part II, about 20 kmph or 12 mph. This exercise was designed to give operators a chance to compare the sound of one slow-moving vehicle with another, a distinction required because the sound signatures of vehicles can differ, depending upon speed.

Part V for both sensors involved a replay of the four convoys that the operators had previously worked with. The convoys were administered in random sequence, and the operators again reported vehicle types on the target logs. Operators were not told that these convoys were the same as those they had just trained with. Feedback was then given, and the operators were asked to score themselves. This procedure not only gave the operators additional practice and motivation, but also gave the facilitators an indication of operator progress.

METHOD OF INVESTIGATION

Population and Sample

The population of concern is the Army-enlisted UGS operators (MOS 17M20) who have been trained at the USAICS. Eighteen UGS operators of the Remote Sensor Platoon of the 101st Airborne Division participated in the experiments.

Apparatus

Two Uher tape recorders (Model 4400 and Model 4000), a feeder box, 11 headsets, and miscellaneous equipment were used to simulate use of the acoustic sensor in the field.[3] This equipment enabled 11 persons (10 operators and 1 facilitator) to listen to the training and test scenarios at the same intensity level. The Uher 4000 was used for training and the Uher 4400 for testing. The frequency response of the Uhers was essentially flat from 50 cps to about 4500 cps at the tape speed (1-7/8 inches per second) used.

Independent Variables

Pretest/Posttest. The effectiveness of training was assessed by a pretest/posttest design. The operators were tested first to determine their baseline performance prior to training and were tested again after training to determine improvement.

Sensor Type. The sensor types tested were the continuous sensor and the intermittent sensor, reflecting differences in concepts of sensing and transmitting the audio signal to the operator.

Scenario. The scenarios were constructed of the taped sounds of convoys simulating sounds the operator would monitor in the field. Two scenarios (A and B) each represented two battalions. Each battalion contained 5 convoys with about 9 vehicles per convoy, for a total of 10 convoys per scenario. The scenarios were roughly matched on the basis of convoy type (wheeled, tracked, and mixed), convoy speed, and vehicle types, and were presented in the same order for both the pretest and the posttest.

Period (Sequential Effects). Each scenario was presented twice in the pretest and twice in the posttest, once in each case for the continuous sensor and once for the intermittent sensor. Operator performance was analyzed mainly to assess practice effects.

Target Type. Seven target types were used: jeep (JP), gamma goat (GG), 2-½-ton truck (2-½T), 5-ton truck (5T), 10-ton truck (10T), armored personnel carrier (APC), and tank (TNK).

Groups. Nine operators were assigned on an availability basis to each of two groups.

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[3]The commercial designation is used for purposes of specific identification of the equipment and does not constitute endorsement by the Army Research Institute or by the Army.

Bandwidth. Three frequency ranges were compared in the exploratory study of bandwidth: 50-1500 cps, 50-2000 cps, and 50-4000 cps.

Dependent Variables

Percent Detection. This variable was the percentage of vehicles detected (number of vehicles reported divided by the number presented).

Percent Identification. This variable was defined as the percentage of vehicles correctly identified (number correct divided by the number presented). The first analysis used the seven vehicle types listed under Target Type, hereafter referred to as the 7-target category. Operators' reports were also scored using the 5-target, 3-target, and 2-target categories shown in Table 1. Use of the 1-target category yielded the measure of percentage of vehicles detected.

Table 1

Target Classification Categories

Categories	Targets				
7-target	JP GG	2-½T	5T 10T	APC	TNK
5-target	Light wheeled	Medium wheeled	Heavy wheeled	APC	TNK
3-target	Light wheeled		Heavy wheeled	Tracked	
2-target	Wheeled			Tracked	
1-target	Vehicle detections				

Statistical Design--Training

In the training experiment, a pretest/posttest design with the same two scenarios for each test was used. Each scenario contained a 2 x 2 x 2 Latin square nested within each cell of the factorial.[4] A schematic presentation of this design is given in Table 2. Because Scenario A always preceded Scenario B, scenario effects were confounded with time effects (motivational changes, learning, etc.). However, this effect is of little consequence because the scenario was included in the design for control purposes only. A more basic weakness in the design is a possible confounding of practice and training. Period effects in the main analyses and a comparison across battalions within scenarios were used to check on practice effects. A consistent scenario effect also could indicate practice effects.

Statistical Design--Bandwidth Experiment

Table 3 gives a schematic presentation of the design for an exploratory study of bandwidth. Three levels of bandwidth (50-1500 cps, 50-2000 cps, and 50-4000 cps) were compared for the continuous sensor case. Statistical significance was assessed using t tests. Data collected under the posttest condition of the training experiment were used for the 50-2000-cps bandwidth condition. Extensive training was not provided in this exploratory study. Training was given only to familiarize the operators with vehicle sounds under the different frequency ranges. The 50-1500 cps and 50-4000-cps training consisted of a paired-vehicle exercise for both fast and slow convoys. This training was administered after the posttest of the training experiment using the same experimental procedures.

Procedure

Each operator participated for 3 days (as shown in Table 4), receiving the orientation briefing and the procedure familiarization (Appendix A) during Day 1. The orientation briefing dealt with the purpose of the study, and the procedure training familiarized the operators with the methods for data collection, both pretest and posttest, and also served as a warmup period. After the test procedure training, the operators were given the pretest (Scenarios A and B).

Day 2 consisted of the training discussed previously, followed by the posttest. Because of a scheduling problem, half the posttest (Scenario A) was administered during Day 2 and the other half (Scenario B) during Day 3. The bandwidth training then followed (Day 3), and the operators were given the post/posttest, using part of Scenarios A and B.

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[4] Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill Book Company, Inc., 1962.

Table 2

Experimental Design--Training Study

Operator groups	Scenario A 1st period	Scenario A 2d period	Scenario B 1st period	Scenario B 2d period
	Pretest (50-2000 cps)			
Group 1 (n = 9)	Continuous	Intermittent	Continuous	Intermittent
Group 2 (n = 9)	Intermittent	Continuous	Intermittent	Continuous
	Posttest (50-2000 cps)			
Group 1 (n = 9)	Continuous	Intermittent	Continuous	Intermittent
Group 2 (n = 9)	Intermittent	Continuous	Intermittent	Continuous

Table 3

Experimental Design--Bandwidth Experiment

50-2000 cps	50-1500 cps	50-4000 cps
Posttest data 5 convoys Continuous sensor	Post/posttest data Same 5 convoys Continuous sensor	Post/posttest data Same 5 convoys Continuous sensor

Table 4

Schedule of Administration

Day 1	AM--Group 1 (9 operators)	Orientation Briefing Test Procedure Familiarization 50-2000 cps Pretest (Scenarios A and B)
	PM--Group 2 (9 operators)	Orientation Briefing Test Procedure Familiarization 50-2000 cps Pretest (Scenarios A and B)
Day 2	AM--Group 1	50-2000 cps Training Posttest (Scenario A)
	PM--Group 2	50-2000 cps Training Posttest (Scenario A)
Day 3	AM--Group 1	50-2000 cps Posttest (Scenario B) 50-1500 cps Training Bandwidth Study 50-1500 cps Post/posttest 50-4000 cps Training 50-4000 cps Post/posttest
	PM--Group 2	50-2000 cps Posttest (Scenario B) 50-4000 cps Training Bandwidth Study 50-4000 cps Post/posttest 50-1500 cps Training 50-1500 cps Post/posttest

Content of Scenarios

Test and training scenarios were constructed, making use of sound signatures taken from magnetic tape recordings collected during a field exercise at Fort Hood, Tex. The exercise consisted of armored and mechanized infantry battalion convoys on both hard-surfaced roads and tank trails, at speeds varying between 5 mph and 40 mph. The acoustic tapes were analyzed to select and categorize convoys on the basis of convoy type (wheeled, tracked, and mixed), speed (fast, slow), target type (JP, GG, 2-½T, 5T, 10T, APC, TNK), and confidence in ground truth data.

The signal-to-noise ratio of the original field tapes was 36 decibels (dB), a figure obtained by comparing the highest signal strength recorded of a tank to the signal strength recorded during a period of no target activity. The quality of the recording equipment used for reproducing a master tape from the field tapes and subsequent reproductions was such that essentially no noise was introduced.

A master tape composed of the 30 convoys in the continuous sensing mode was made, with the bandwidth clipped to 50-2000 cps (to correspond to the operational bandwidth); another master tape of 9 of these convoys in the continuous mode was made at 50-5000 cps.

Convoys for the test and training tapes were selected from the convoys on each master tape. From the 50-2000-cps master tape, 20 convoys were selected for the 50-2000 cps test tape, and 7 for the 50-2000-cps training tape. Out of the nine convoys of the 50-5000-cps master tape, five were selected for dual use in the training and bandwidth experiments and were reduced in bandwidth as necessary. Composition of the test tapes is shown in Table 5. During the taping of the 50-2000-cps test tape, the continuous sensor scenario was taped directly from the master tape. This tape was then used with an in-line timer to reproduce the tape for the intermittent condition and to insure a 4-second target signal with about 2 seconds of silence between vehicles.

Table 5

Composition of Convoys on the 50-2000-cps Scenario Test Tapes

Field[a] tape no.	Convoy no. and composition	Speed	Vehicle types JP	GG	2-½T	5T	10T	APC	TNK	Totals
4	1 Tracked (T)	Slow	0	0	0	0	0	6	3	9
3+5	2 Wheeled (W)	Fast	1	0	3	4	0	0	0	8
6	3 Mixed (M)	Slow	2	0	1	0	[illegible]	4	0	9
4[b]	4 W	Slow	1	0	0	4	0	0	0	5
4	5 M	Fast	0	1	1	0	1	4	2	9
	1st Battalion total		4	1	5	8	3	14	5	40
6[b]	1 W	Fast	4	0	2	0	2	0	0	8
6	2 T	Fast	0	0	0	0	0	4	4	8
6+5	3 W	Fast	2	3	1	1	2	0	0	9
4[b]	4 T	Slow	0	0	0	0	0	6	2	8
6	5 M	Fast	3	1	0	0	1	6	1	12
	2nd Battalion total		9	4	3	1	5	16	7	45
	Scenario A	Total	13	5	8	9	8	30	12	85
4	1 T	Slow	0	0	0	0	0	5	5	10
4	2 M	Slow	1	0	1	6	0	3	0	11
6	3 W	Fast	2	3	0	0	2	0	0	7
4	4 T	Slow	9	1	1	0	0	0	0	11
6	5 T	Slow	0	0	0	0	0	4	3	7
	3rd Battalion total		12	4	2	6	2	12	8	46
6	1 W	Fast	3	1	3	0	0	0	0	7
6	2 M	Fast	0	3	3	0	0	4	0	10
4[b]	3 T	Slow	0	0	0	0	0	3	5	8
3	4 W	Fast	1	0	0	5	0	0	0	6
6	5 M	Fast	1	[illegible]	1	0	4	1	3	11
	4th Battalion total		5	5	7	5	4	8	8	42
	Scenario B	Total	17	9	9	11	6	20	16	88
		Grand totals	30	14	17	20	14	50	28	173

[a]The field tape numbers are given for future reference.

[b]Also 50-1500 and 50-4000 test tape.

During the taping of the continuous sensor convoys, the individual vehicle signals were clipped to about 6 seconds in order to better simulate operational conditions. This reduction was necessary, because during peacetime maneuvers vehicles travel much farther apart than they would in a wartime road march. Based on estimated traveling intervals and speeds of aggressor convoys,[5,6] it was determined that enemy vehicles travel about 6 seconds apart; that is, one vehicle would pass the acoustic sensor every 6 seconds. This time separation between vehicles is relatively constant for day and night travel. During the night, however, both the vehicle speed and the distance between vehicles are less than during the day. The time between individual convoys and battalions also was made to correspond to wartime operation conditions during the taping.

Several of the convoys were also used in the pos'/posttest tape (Table 5). This tape involved the continuous mode only at 50-1500 cps and at 50-4000 cps but was otherwise identical to that used in the 50-2000 condition. Table 6 describes the seven convoys used in the 50-2000-cps training tape. A separate training tape was used for the 50-1500-cps and 50-4000-cps conditions.

Scoring Criteria

Operator reports were scored as follows.

Vehicle Detection. If an operator reported a vehicle (by any name) when there was a vehicle, it was scored as a detection.

Vehicle Identification. Because the operator had only about 6 seconds to recognize and report a vehicle and was required to give an exact identification (truck or jeep, for example), he sometimes reported fewer vehicles than were present, especially with the continuous sensor. In case of an omitted target, a flexible scoring strategy was used that allowed maximum credit for vehicles reported out of sequence. Had a more rigid scoring key been used, a vehicle reported out of sequence might have been scored as an error.

In practice, depending on field requirements, a combat commander requests information at different levels of detail. Generally, the more detailed the reported information, the greater the error rate. A combat commander may prefer very accurate gross information or relatively inaccurate detailed information. For this reason, operator reports were scored using different categories of target identification, each successively more detailed.

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[5] Military Publishing House. Combat Actions at Night. Moscow, DIA. 1970.

[6] Field Manual FM 30-102. Handbook on Aggressor. HQ, Department of the Army. June 1976, pp. 20-23.

Table 6

Composition of Convoys for Training (50-2000 cps)

Field[a] tape no.	Convoy no. and composition	Speed	Vehicle types JP	CG	2-½T	5T	10T	APC	TNK	Totals
6	1. Mixed	Fast	2	1	0	0	0	1	3	7
6	2. Wheeled	Fast	1	3	4	0	0	0	0	8
3	3. Track	Slow	0	0	0	0	0	5	4	9
4	4. Track	Slow	0	0	0	0	0	8	0	8
6	5. Mixed	Fast	2	0	0	1	1	1	4	9
6	6. Wheeled	Fast	1	3	4	0	0	0	0	8
6	7. Wheeled	Slow	3	0	3	0	2	0	0	8
		Totals	9	7	11	1	3	15	11	57

[a]The field tape numbers are given for future reference.

For the 1-target (detection) category, if the operator responded when there was a vehicle, regardless of vehicle type, it was scored as a detection.

For the 2-target category, if an operator correctly reported a vehicle as a wheeled vehicle, it was scored as a correct identification regardless of exact target type. A similar procedure was used for tracked vehicles.

For the 3-target category, if an operator reported any of the vehicles under the light wheeled category (see Table 1), it was scored as a correct identification. A similar procedure was used for the heavy wheeled and tracked vehicles.

For the 5-target category, if an operator reported either of the vehicles under the light wheeled category (Table 1), it was scored as a correct identification. A similar procedure was used for the heavy wheeled category. For the medium wheeled, APC, and tank targets, credit was given only to exact reports of 2-1/2T, APC, and TNK.

For the 7-target category, credit was given only for exact identification of each vehicle type. The flexible scoring strategy was maintained throughout all the categories.

RESULTS AND DISCUSSION

Results are presented for each of the five levels of target identification required, starting with the most detailed.

The 7-Target Category

An analysis of variance was conducted on the number of correct identifications of the 7-target category (Table 7). The percentages of correct identification averages are presented in Table 8.

The groups' effect and all interactions with groups were nonsignificant, indicating that the two groups of UGS operators were similar in ability to identify vehicles using the acoustic sensor.

Table 7

Analysis of Variance of Correct 7-Target Category Identification

Source of variation	df	SS	MS	F	Significance level
Between subjects	17	4,835.72	78.03	.26	NS
Groups	1	78.03			
Subject within groups	16	4,757.69			
Within subjects	126	8,368.50			
Sensor type	1	240.25	240.25	10.79	.01
Period	1	160.44	160.44	7.21	.05
Residual (1)	16	356.31	22.27		
Scenario	1	144.00	144.00	4.90	.05
Scenario x groups	1	42.25	42.25	1.44	NS
Residual (2)	16	470.25	29.39		
Pre/post	1	4,203.36	4,203.36	62.39	.01
Pre/post x groups	1	18.77	18.77	.28	NS
Residual (3)	16	1,077.87	67.37		
Scenario x pre/post	1	78.03	78.03	5.10	.05
Scenario x pre/post x groups	1	13.45	13.45	.88	NS
Residual (4)	16	244.75	15.30		
Sensor type x scenario	1	.30	.30	.91	NS
Period x scenario	1	1.99	1.99	.06	NS
Residual (5)	16	534.63	33.41		
Sensor type x pre/post	1	4.01	4.01	.16	NS
Period x pre/post	1	61.33	61.33	2.43	NS
Residual (6)	16	404.52	25.28		
Sensor type x scenario x pre/post	1	.00	.00	.00	NS
Period x scenario x pre/post	1	.03	.03	.00	NS
Residual (7)	16	282.48	17.66		
Total	143	13,204.22			

Table 8

Mean Percent Correct Identification for the 7-Target Category

Sensor type	Pretest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 24%	Group 2 28%	Group 1 23%	Group 2 28%	26%
Intermittent	Group 2 28%	Group 1 32%	Group 2 26%	Group 1 29%	29%
Averages	26%	30%	24%	28%	27%

Sensor type	Posttest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 40%	Group 2 41%	Group 1 34%	Group 2 39%	39%
Intermittent	Group 2 44%	Group 1 40%	Group 2 40%	Group 1 36%	40%
Averages	42%	40.5%	37%	37.5%	39%

The effect of sensor type (continuous vs. intermittent) was significant. Use of the continuous sensor resulted in an average of 32.1% correct identifications, whereas use of the intermittent sensor resulted in an average of 34.4% correct identifications. Thus, although the operators had only 4 seconds in which to identify a vehicle in the intermittent condition (as compared to 6 seconds in the continuous), they still correctly identified a greater number of vehicles. The advantage probably occurred because each vehicle in a convoy in the intermittent condition is separated by a 2-second silent period and thus is easier to detect than vehicles in the continuous sensor condition; for the latter condition, the operator must detect the passing of each vehicle by its characteristic changes in intensity and frequency.

The small but significant difference between the two sensor types (32.1% vs. 34.4%) would seem minimal in the practical sense. However, in an actual convoy situation in the field, the difference between the continuous and intermittent sensors would probably be greater because of the manner of recording under the continuous sensor condition. The convoys recorded in the field were traveling under peacetime maneuver regulations, and the time between vehicles was longer than it would be in wartime. These intervals were shortened appropriately in order to better simulate operational conditions; in the process, some recognizable "clicks" between vehicles were caused when the tape recorder was stopped or started. Thus, even though there were no distinct silences between vehicle sounds (as with the intermittent condition), these clicks (which are artifacts of the simulation) may have helped operators to discriminate between successive vehicles and may thereby have artificially raised their detection and identification scores in the continuous sensor condition. The difference would probably be greater in an operational situation.

The statistically significant pretest/posttest effect indicates that training did enhance operator performance. As shown in Table 8, the pretest average is 27% correct identification and the posttest average is 39%. In other words, the training increased operator performance by 12 percentage points, for a 44% increase in performance.

Period, or order, effect was also statistically significant. Period 1 average is 32% and Period 2 average is 34%, suggesting that practice during the test administration may have contributed to the increase from pretest to posttest performance. The interaction of period and pretest/posttest was not significant, indicating that the significant period effect was distributed over both pretest and posttest. The gain in performance attributable to practice effects is minimal compared to the large pretest/posttest differences (See Appendix B for additional analyses.) Thus, the conclusion that training enhanced operator performance appears valid.

The remaining statistically significant effects are scenario and the scenario by pretest/posttest interaction. Scenario A resulted in an overall performance average of 35% correct identification, and Scenario B resulted in 31.5% correct identification. Since Scenario A was presented

to the subjects first, and Scenario B second, there is no way of knowing whether the significant scenario effect is due to differences in scenario difficulty or time effects (e.g., motivation).

The interaction of scenario and pretest/posttest was significant. The scenarios were similar in performance for the pretest (Scenario A, 28%; Scenario B, 26%) but dissimilar for the posttest (Scenario A, 42%; Scenario B, 37%). This result is probably attributable to the necessity for dividing the posttest into two sections and administering the sections on two different days; this break in continuity may account for the lower posttest scores on Scenario B.

The results were further analyzed on the basis of target type to determine the differential effects of training (Table 9). The training had the greatest impact on jeeps, gamma goats, 10-ton trucks, APC's, and tanks, and the least effect on 2-½-ton and 5-ton trucks.

Table 9

Mean Percent Correct 7-Target Identification by Target Type and Pretest-Posttest

Period	JP	GG	2-½T	5T	10T	APC	TNK
Pretest	18	17	26	17	22	29	50
Posttest	28	29	29	20	33	51	60

The 5-Target Category

For the 5-target category, jeeps and gamma goats were combined as light wheeled vehicles, the 2-½-ton trucks were considered medium wheeled vehicles, the 5-ton and 10-ton trucks were grouped as heavy wheeled vehicles, the armored personnel carriers as light tracked, and tanks as heavy tracked. The results for this category are presented in Table 10.

A statistically significant difference was found between the pretest and posttest results ($t = 7.47$, $df = 17$, $p > .01$). The pretest overall average was 31.5% identification and the posttest average 45% identification. The percentage increase over pretest performance was 43%.

Table 10

Mean Percent Correct Identification for the 5-Target Category

Sensor type	Pretest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 27%	Group 2 31%	Group 1 28%	Group 2 33%	30%
Intermittent	Group 2 33%	Group 1 35%	Group 2 32%	Group 1 32%	33%
Averages	30%	33%	30%	33%	31.5%

Sensor type	Posttest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 44%	Group 2 45%	Group 1 39%	Group 2 44%	43%
Intermittent	Group 2 49%	Group 1 48%	Group 2 45%	Group 1 44%	46.5%
Averages	46.5%	46.5%	42%	44%	45%

Although an analysis of variance was not conducted, several generalizations can be made. The relationships between the variables are similar to those in the 7-target category data. Overall, operator performance was slightly higher because less target detail was required. The difference between the continuous and intermittent sensors was about the same as with the 7-target identification level--36% versus 40%, respectively.

The data were further analyzed on the basis of target type (Table 11). The training had the greatest impact on light wheeled vehicles, APC's, (or light tracked), and tanks (heavy tracked). The training had least effect on medium and heavy wheeled vehicles.

Table 11

Mean Percent Correct 5-Target Identification by Target Category and Pretest/Posttest

Period	Light wheeled	Medium wheeled	Heavy wheeled	Light tracked	Heavy tracked
Pretest	28	26	28	29	50
Posttest	42	29	34	51	60

The 3-Target Category

For the 3-target category, the jeeps, gamma goats, and 2-½-ton trucks were combined as light wheeled vehicles, the 5-ton and 10-ton trucks as heavy wheeled vehicles, and the APC and tank as tracked vehicles. Results are presented in Table 12. A t test indicated a statistically significant difference between the pretest and posttest results ($t = 5.77$, $df = 17$, $p > .01$). The pretest overall average was 53% identification, and the posttest average, 62%.

Overall performance was considerably higher when operators were required to deal with only three target types than when they had to distinguish between seven or five target types. At the same time, percentage of improvement due to training declined with the fewer target types: seven targets, 46%; five targets, 43%; and three targets, 18%. Differences between pretest and posttest results were somewhat similar: seven targets, 13%; five targets, 13%; and three targets, 9%; differences between the continuous and intermittent sensor types also were similar: 2%, 4%, and 5% correct identifications, respectively.

Table 12

Mean Percent Correct Identification for the 3-Target Category

Sensor type	Pretest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 47%	Group 2 52%	Group 1 47%	Group 2 52%	49.5%
Intermittent	Group 2 58%	Group 1 60%	Group 2 55%	Group 1 53%	56.5%
Averages	52.5%	54.5%	51%	52.5%	53%

Sensor type	Posttest				
					Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 62%	Group 2 61%	Group 1 55%	Group 2 62%	60%
Intermittent	Group 2 65%	Group 1 67%	Group 2 64%	Group 1 60%	64%
Averages	63.5%	64%	59.5%	61%	62%

The results were further analyzed on the basis of target type. The percentage of correct identifications of light wheeled vehicles increased through training from 47% to 56%, of heavy wheeled vehicles from 28% to 34%, and of tracked vehicles from 58% to 79%.

An additional 3-target category that may be operationally useful is wheeled vehicles, APC's, and tanks. Using this breakdown, the pretest overall average was 53% correct identifications and the posttest 67%--a percentage increase of 26%.

The 2-Target Category

The results for the 2-target category (wheeled and tracked vehicles) are presented in Table 13. A t test conducted on these data indicated a statistically significant difference between the pretest and posttest results ($t = 4.83$, $df = 17$, $p > .01$). The pretest overall average was 68% correct identifications, and the posttest average, 78.5%. The percentage increase over pretest performance was 15%.

As expected, performance substantially increased as the amount of required target detail was reduced. In some tactical situations, convoy information in terms of wheeled and tracked vehicles would be completely satisfactory. The difference between the continuous (69.5%) and intermittent (77%) sensors is consistent with the previous results but slightly higher. Using the intermittent sensor, the operators identified 11% more vehicles.

Scenario differences (significance was not tested) apparently reversed directions for the 2-target category: performance on Scenario A was about 3% less than on Scenario B. This result may reflect the higher percentage of wheeled vehicles in Scenario B--the scenarios are more difficult when the operator must distinguish among types of wheeled vehicles.

The results were further summarized by target type. The percentage of correct identifications of wheeled vehicles increased through training from 67% to 78%, and of tracked vehicles, from 68% to 79%.

The 1-Target Category

The results for the 1-target category (which is the same as detecting and counting the vehicles) are presented in Table 14. A t test indicated a statistically significant difference between pretest and posttest results ($t = 4.32$, $df = 17$, $p > .01$). The pretest overall average was 89% detection, and the posttest average, 95%. The percentage of increase over pretest performance was 7%.

Table 13

Mean Percent Correct Identification for the 2-Target Category

Sensor type	Pretest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 55%	Group 2 65%	Group 1 61%	Group 2 70%	63%
Intermittent	Group 2 72%	Group 1 69%	Group 2 81%	Group 1 68%	72.5%
Averages	63.5%	67%	71%	69%	68%

Sensor type	Posttest				
	Scenario A		Scenario B		Average
	Period 1	Period 2	Period 1	Period 2	
Continuous	Group 1 74%	Group 2 73%	Group 1 73%	Group 2 84%	76%
Intermittent	Group 2 78%	Group 1 82%	Group 2 86%	Group 1 77%	81%
Averages	76%	77.5%	79.5%	80.5%	78.5%

Table 14

Mean Percent Target Detection for the 1-Target Category

Sensor type	Pretest: Scenario A, Period 1	Pretest: Scenario A, Period 2	Pretest: Scenario B, Period 1	Pretest: Scenario B, Period 2	Average
Continuous	Group 1 81%	Group 2 85%	Group 1 85%	Group 2 88%	85%
Intermittent	Group 2 95%	Group 1 93%	Group 2 94%	Group 1 90%	93%
Averages	88%	89%	89%	89%	89%

Sensor type	Posttest: Scenario A, Period 1	Posttest: Scenario A, Period 2	Posttest: Scenario B, Period 1	Posttest: Scenario B, Period 2	Average
Continuous	Group 1 91%	Group 2 93%	Group 1 89%	Group 2 96%	92%
Intermittent	Group 2 96%	Group 1 98%	Group 2 98%	Group 1 95%	97%
Averages	93.5%	95.5%	93.5%	95.5%	94.5%

Differences between the continuous sensor and intermittent sensor (89% versus 95% detection) were not as large as expected, either with one category of target or throughout the 7-, 5-, 3-, and 2-target categories. As explained earlier, the tape recorder "clicks," which were a necessary evil in building the master tapes, probably cued the operators as to vehicle sequence and produced overinflated scores for the continuous sensor condition. This difference in target detection largely accounts for the differences found in the identification of targets (target categories 2 through 7).

Field Selection of Operators

The data were also examined by arranging the operators into three groups on the basis of pretest performance. The mean percent correct identifications, differences, and correlation coefficients for pretest and posttest performance are presented in Table 15. Pretest scores correlated significantly with posttest performance, indicating that a performance test such as the pretest could be used to assign individuals to the acoustic monitoring task. The increase in performance associated with using only the top third can be seen in Table 15 for each target category.

The differences between pretest and posttest performance seem to indicate that lower ability groups tended to gain more from training for the easier tasks, i.e., the 2-target and 3-target categories. The groups seemed to gain equally from training for the harder tasks.

The Bandwidth Study

An exploratory investigation (five convoys) was made to determine the effects on operator performance of the use of different frequency ranges in the continuous sensor condition. The 50-1500-cps and the 50-4000-cps frequencies were compared with each other and with the currently used 50-2000-cps range in the 7-target case only. The percent identification averages for the three frequencies are 22% (1500 cps), 29% (2000 cps), and 24% (4000 cps). The t tests were as follows:

1500 cps vs. 2000 cps ($t = 2.11$, $df = 17$, $p > .05$)
1500 cps vs. 4000 cps ($t = 1.05$, $df = 17$, NS)
2000 cps vs. 4000 cps ($t = 1.46$, $df = 17$, NS)

The statistically significant difference between the 1500-cps and 2000-cps condition indicates that the frequency range currently used by the Army (50-2000 cps) should not be reduced. On the other hand, the data also suggest that the higher frequency range (50-4000 cps) may not result in higher interpretability. These data indicate that the 50-2000-cps range currently used by the Army is adequate.

Table 15

Pretest/Posttest Comparisons of Operators Grouped on the Basis of Pretest Performance (Percent Correct Identification)

Category	Operator group	Pretest	Posttest	Difference	Correlation
7-target category	Upper third	34	47	13	
	Middle third	26	36	10	.69*
	Lower third	22	34	12	
5-target category	Upper third	39	50	11	
	Middle third	30	46	16	.57**
	Lower third	25	39	14	
3-target category	Upper third	61	66	5	
	Middle third	52	61	9	.55**
	Lower third	45	58	13	
2-target category	Upper third	77	80	3	
	Middle third	67	79	12	.57**
	Lower third	59	75	14	
1-target category	Upper third	95	96	1	
	Middle third	90	94	4	.48**
	Lower third	81	93	12	

*Significant at .01.
**Significant at .05.

The administration of the bandwidths was counterbalanced for the two groups, i.e., Group 1 received the 1500-cps bandwidth first, and Group 2 received the 4000-cps bandwidth first. A check on the group averages shows order effects as minimal--the results for Group 1 are 24% (1500 cps) and 24% (4000 cps) and the results for Group 2 are 24% (4000 cps) and 20% (1500 cps).

SUMMARY OF RESULTS AND FIELD IMPLICATIONS

Several aspects of the current experiment should be considered when the results of this study are used. The continuous sensor results may be inflated somewhat over what would be obtained in an actual field situation because of tape recorder "clicks" between vehicles, which may have

acted as cues to the operators. The signal/noise ratio of 36 dB (based on the signal of the loudest vehicle) may be better than in the usual sensor conditions and may have inflated performance. On the other hand, in the process of compiling the test tapes from field-collected tapes, changes in the dynamic range of signal strength may have resulted in lowered performance. Presenting fast and slow convoys in a random order rather than as a string of convoys at similar speeds may have lowered performance.

The scenario material used in these experiments was based on tape recordings of actual vehicle convoys during field maneuvers and developed to simulate actual field conditions. The results represent the best estimates to date of what the commander might expect from regularly and specially trained operators.

If the commander requires that convoy vehicles be reported in detail (7-target category--jeep, gamma goat, 2-½-ton truck, 5-ton truck, 10-ton truck, APC, and tank), he can expect 27% correct identification before special training and 40% after training, a difference of 13 percentage points and an improvement of 46%. The training results for each target category are shown below.

If the commander requires convoys reported in	Today's operators will get	Operators with extra training will get	Which is a difference of	Or an increase of
7-target category (exact identification)	27% correct	40% correct	13%	46%
5-target (light, medium, and heavy wheeled, APC, and tank)	32% correct	43% correct	11%	43%
3-target (tracked and light and heavy wheeled vehicles)	53% correct	62% correct	9%	18%
3-target (APC, tank, and wheeled vehicles)	53% correct	67% correct	14%	26%
2-target (wheeled and tracked vehicles)	68% correct	78% correct	10%	16%
1-target category (counting)	89% correct	95% correct	6%	7%

Based on the results of this study, the training materials developed have a significant impact for field use and should be incorporated in school training and be circulated to UGS units for on-the-job refresher training. The training is most effective for jeeps, gamma goats, APC's, and tanks, and least effective for 2-½-ton trucks, 5-ton trucks, and 10-ton trucks. Units using this training package should enhance the existing tapes by collecting additional sound signatures of these three vehicle types. Optimally, sounds of aggressor vehicles should replace those of U.S. vehicles in the training simulation.

Sound recognition to the level of specific vehicle identification is a difficult perceptual task. However, operators can be trained to improve significantly their ability to interpret vehicle sounds, using either the continuous or the intermittent sensors. When performance was averaged over all levels of target reporting, operators reported about 10% more information before special training and 6% more after training, using the intermittent sensor rather than the continuous sensor.

Results show that operators can effectively monitor convoys and that both the continuous and intermittent sensors are superior to the current AAU sensor in the amount of information obtained. The continuous and intermittent sensors have 100% information potential, whereas the AAU has about 50% maximum. The two should be considered for use in REMBASS.

The research also shows that operators differ greatly in ability to identify vehicles using the acoustic sensor. If only those operators with superior sound-recognition ability were used to perform this task in field units, a substantial gain in information would result. For example, if commanders were to routinely assign present-day operators (not specially trained) to the continuous sensor to identify tracked and wheeled vehicles, they could expect about 68% of the enemy vehicles to be properly identified. If they were to use only the top third of these operators, then 77% of the enemy vehicles would be properly identified. Better performance still would be expected if only the intermittent sensor and specially trained operators were used. The better operators can be identified by means of the test scenarios already developed for this training program.

In sum, optimal information output can be achieved by using the top third of specially trained operators and the intermittent type of sensor. The results of this research indicate that under such conditions, 85% of tracked and wheeled vehicles can be correctly identified; 72% accuracy can be achieved under these conditions in identifying three target categories--light wheeled, heavy wheeled, and tracked vehicles. Corresponding accuracy for the average, regularly trained operator using the continuous sensor is 63% and 50%, respectively, a difference of 22% in each case.

APPENDIX A

FACILITATOR GUIDE

Classroom Needs

1. Tape recorder
2. Feeder box with female plugs (optional)
3. Headset for each operator (optional)
4. Target logs, pencils, etc.

Orientation briefing - about 10 min. A-1

Test Procedure Familiarization - about 40 min. A-5

Pretest - (10 convoys each)
Continuous convoys 1-10 - about 20 min.
Intermittent convoys 1-10 - about 20 min.
Continuous convoys 11-20 - about 22 min.
Intermittent convoys 11-20 - about 22 min.

Training - 50-2000 cps bandwidth

Part 1 - Intermittent Sound (Voice Feedback) Convoys 1 and 2 - about 30 min. A-10

Part II - Fast Speed - Vehicle Pairs - about 15 min. A-12

Part III - Intermittent Sound (Voice Feedback) Convoys 3 and 4 about 15 min. A-14

Part IV - Vehicle Pairs - Slow Speed - about 15 min. A-15

Part V - Intermittent Sound - Practice Convoys 1,2,3, and 4 - about 10 min. A-16

Part I - Continuous Sound (CPA Feedback) Convoys 1 and 2 - about 25 min. A-19

Part II - Vehicle Pairs - Fast Speed - about 15 min. A-22

Part III - Continuous Sound (CPA Feedback) Convoys 3 and 4 - about 15 min. A-23

Part IV - Vehicle Pairs - Slow Speed - about 15 min. A-24

Part V - Continuous Sound - Practice Convoys 1,2,3, and 4 - about 10 min. A-25

Posttest

Continuous - Convoys 1-10 - about 20 min.

Intermittent - Convoys 1-10 - about 20 min.

Continuous - Convoys 11-20 - about 22 min.

Intermittent - Convoys 11-20 - about 22 min.

FACILITATOR GUIDE

ORIENTATION BRIEFING (10 min.)

Facilitator: Read the following:

I want to welcome everyone here today. We are glad that you could make it and can participate in the exercise we have planned. You will be participating in this exercise a half-day today, a half-day tomorrow, and half of the following day. We think you will find it interesting and worthwhile to your job in the Remote Sensor Platoon. We will be spending an hour briefing you and giving you an orientation as to what it is all about. Before going any further, I want to introduce myself and my associate and find out who you are.

Introduction

Recent requirements in the Army Unattended Ground Sensor (UGS) community have identified a need for human factors studies and training development in the area of sound recognition while monitoring acoustic UGS. The need for studies and training development in sound recognition is desired by UGS field units, the REMBASS program, the United States Army Intelligence Center and School at Ft. Huachuca, and the NATO project "Avid Guardian" in Europe.

Acoustic sensors are the best confirmation sensors in the Army today, but their full potential has not been realized primarily because of a lack of knowledge on the part of the commander and new system developers concerning what the operator can and cannot do. Much of the information that the commander can use doesn't even exist. That is why we are here--to collect performance data which can be used by the commander and new system developers for doctrine, tactics, and systems specification. By participating in this exercise, you, the UGS operator, are helping to answer questions such as:

1. How well can an operator recognize different military vehicles in convoy by listening to the sound that they make?
2. What difference does transmission time make, including very short ones? Using short transmission times has the advantages of longer battery life and reduced chances of electronic detection.
3. To what extent can an operator be trained to increase his ability to recognize the sounds of military vehicles in convoy?
4. Does increasing the frequency (freq.) range significantly improve sound recognition performance?

The Army is interested in improving surveillance techniques to maximize information output and make the job easier for you. Through its Remotely Monitored Battlefield Surveillance System (REMBASS), the Army is currently planning to include two acoustic sensors in its inventory for the 1980's. These two REMBASS sensors are called the (1) Acoustic Analog Sensor (DT-5XX) and the (2) Seismic/Acoustic Classification Sensor (DT-562).

The Acoustic Analog Sensor is simply an advanced version of the Audio Add-On Unit (AAU) which you are familiar with. It will drive a speaker/headset for aural analysis by the operator. Because the operator is interpreting, the report is limited only by the operator's ability. Operator training plus differences in frequency may significantly improve his performance.

The Seismic/Acoustic Classification Sensor will utilize internal logic and digital information processing to automatically classify targets. However, the classification is at a gross level and includes only tracked vehicles, wheeled vehicles, and personnel. This sensor will send only a beep every 10 seconds as its output. It will automatically display a T, W, or P on the tac recorder.

During these exercises, your task as a sensor operator will be to listen to tape recordings of military convoys and report what you think you hear. Many of the skills you have acquired in school and on the job will apply. All of you probably have had personal experiences which will apply in that you have heard all of the vehicles at sometime in your life. Today, you will hear recorded sounds of Army vehicles which you will report on a

simple form called a Target Log. You'll do this for about an hour and-a-half, and then receive some training. You will be given specific times to ask questions so that the planned exercise will not be interrupted.

You will hear taped sounds of military vehicle convoys as you would hear them from a modified AAU employed in a field exercise. The aggressor will be traveling in convoys averaging about 10 vehicles (each traveling about 6 seconds apart). The one problem you will have to deal with is the sound of a loud vehicle partially degrading or masking the sound of a quieter vehicle. Another problem is to make a quick decision about a particular vehicle, record it, and still listen to the convoy. You will record your answers using our procedures and forms. Since we know what made the sounds, we can score your report forms for accuracy. We don't expect 100% performance for all targets, but just that you try as hard as you can as though this was a combat situation. As stated earlier, each of you will participate for a half-day for three days. You must be here for all scheduled times or we won't be able to use your results.

I would like to emphasize that we are not giving you a test to see how good an operator you are. We are here to improve the Army's capability for using the acoustic sensor. All we ask is that you interpret the sounds to the best of your ability and try to make sense out of what sometimes might appear to you to be rather difficult. You are important because you as a group represent the hundreds of UGS operators that have and will be assigned to Remote Sensor Platoons, but the first to participate in this kind of exercise. The use of acoustic sensors in the future will be partially based upon what you can do.

It is not the purpose of this exercise to sample all possible vehicles or circumstances involving the use of acoustic sensors. This exercise does attempt to sample the sound signatures of certain types of vehicles in a convoy situation using a certain type of sound recording system.

In addition to being relevant to your job in this platoon, there might be another personal advantage for you to do well during this exercise. At various times trained volunteers are requested to serve in various places

that you might find attractive, such as at Ft. Chaffee, Ark., or Europe. Of course, there is no guarantee that even if you do well on this exercise you will be swept away to a promised land, but doing well on this exercise sure wouldn't hurt your chances.

TEST PROCEDURE FAMILIARIZATION (40 min.)

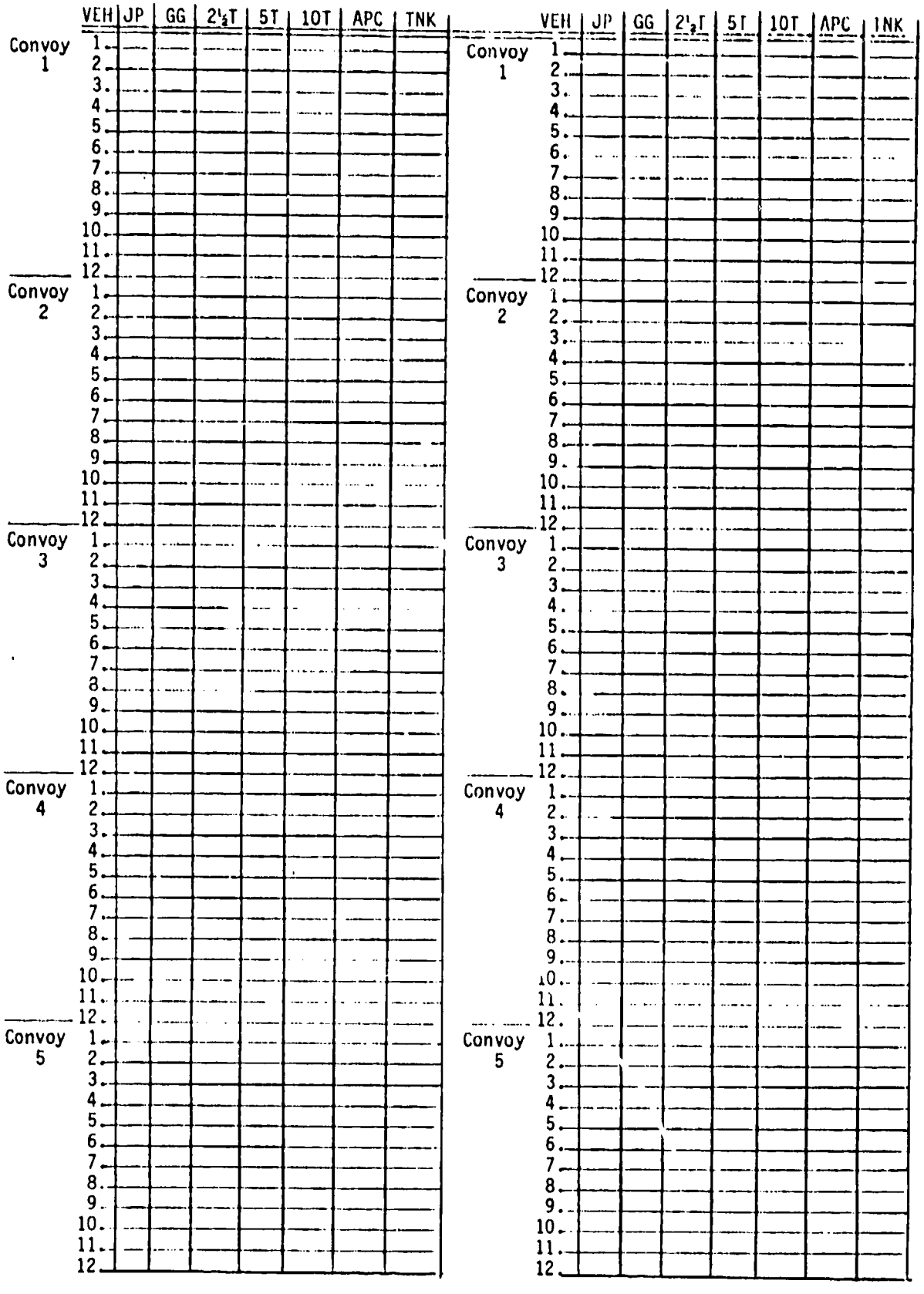
Facilitator: Read the following

This exercise simulates the European theatre in which aggressor convoys are attacking NATO's western boundary. Assume that you are in Germany monitoring two types of acoustic sensors. These acoustic sensors are similar to the AAU except that they "listen" at different times than the AAU. As you know, the AAU "listens" for 15 seconds after being triggered by three seismic activations within a 28-second period. Your first acoustic sensor will "listen" continuously for the type of aggressor convoys expected. This first sensor we will call the Continuous Sensor. Your second sensor will listen about 4 seconds for each vehicle. Since it listens intermittently, it is called the Intermittent Sensor.

These sensors will present a target's sound signature to you when the target is closest to the sensor. This point is called the CPA which stands for closest-point-of approach. This is the point where the vehicle should sound the loudest and where you would have the best chance of identifying it.

Your commander has tasked you with the job of monitoring these acoustic sensors for vehicle identification purposes. The order of battle (OB) indicates that the aggressor force will be using convoys averaging around 10 vehicles apiece. Speed and traveling intervals of the convoys will affect how you hear each vehicle but the vehicle separation will be around 6 seconds. The first and last vehicles you will probably hear longer.

Your commander has given you a Target Log which you will use to record vehicle activity. Look at the Target Log that is being passed out now. (Pass out Target Logs). First, fill out the information that is requested



TARGET LOG

Name _____

Date _____

Half _____

along the right-hand side. Also, put your rank with your name. I'll wait while you do this (about one minute). Notice at the top of the Target Log that your commander is interested in seven vehicles that he knows will be in these convoys. He wants you to place an X in the appropriate column for each vehicle so that he can know how many of each kind in order to determine the threat level. These target types are:

1. Jeeps (shown as JP)
2. Gamma Goats (shown as GG)
3. 2½-ton trucks (shown as 2½T)
4. 5-ton trucks (shown as 5T)
5. 10-ton trucks (shown as 10T)
6. Armored personnel carriers (shown as APC)
7. Tanks (shown as TNK). Almost all the tanks are M-60's. If you hear any Sheridan tanks, just list them as tanks along with the M-60.

Notice that there are spaces for 10 convoys on your Target Log with a maximum of 12 vehicles per convoy--five convoys are on the left and five on the right. Are there any questions?

Before we go any further, we want to give you some practice in listening to convoys and recording your answers on the Target Log. You will start on the left-hand side of the Target Log. Notice again that there are five convoys with a maximum of 12 vehicle answer spaces per convoy. A maximum of 12 vehicle answer spaces is given because your commander knows that the aggressor convoys will have anywhere from five to 12 vehicles in each convoy. In this study, five convoys will be equivalent to a Bn level unit.

During this exercise you will be told when a Bn of five convoys is approaching. You will also be told when each convoy in the Bn is approaching your acoustic sensor. This information is what you would normally get from your seismic sensors. The convoys will be traveling at various speeds but your intelligence reports indicate that the time separation between each vehicle will be only 4-10 seconds.

Now, let's run through three convoys to make sure there aren't any misunderstandings and to give you a little practice. The first convoy is monitored by the CONTINUOUS SENSOR. Remember, for each vehicle in the convoy, record your answer with an X. Try to maintain the proper sequence of vehicles throughout the convoy and start on the left side of the Target Log where it says convoy 1. Are there any questions? OK. If the sound is too loud, raise your hand.

Facilitator: Play mixed convoy out of training tape A (counter numbers 178-186). As this convoy is playing, check to see that everybody understands the procedure.

OK, how did everybody do? Now I will give you the answers for this convoy in the sequence that they occurred, then we will replay it.

(178)

Vehicle 1	TNK
Vehicle 2	TNK
Vehicle 3	TNK
Vehicle 4	TNK
Vehicle 5	APC
Vehicle 6	APC
Vehicle 7	APC
Vehicle 8	APC
Vehicle 9	APC
Vehicle 10	APC

Facilitator: Replay the convoy (185-203.5).

I think you will see that you must concentrate on the sounds. Now we will listen to another convoy. Remember to place an X in the right column for your answers. It is important for you to start on the left side of the Target Log where it says convoy 2.

Facilitator: Play wheeled convoy (counter reading 186-190).

OK, how did everybody do? Now I will give you the answers for this convoy in the sequence that they occurred, then we will replay it.

(204)

Vehicle 1 ___2½T___
Vehicle 2 ___10T___
Vehicle 3 ___10T___
Vehicle 4 ___2½T___
Vehicle 5 ___JP___
Vehicle 6 ___JP___
Vehicle 7 ___2½T___
Vehicle 8 ___JP___
Vehicle 9 ___JP___

Facilitator: Replay this convoy (204-211.5).
Now we will listen to another convoy in which the Intermittent Sensor is used and each vehicle will be heard about four seconds. It is important that you start on the right side of the Target Log where it says convoy 1. Any questions?

Facilitator: Play tracked convoy (027-035).
The answers to this convoy in the proper sequence are as follows:

(027.5)

Vehicle 1 ___TNK___
Vehicle 2 ___TNK___
Vehicle 3 ___JP___
Vehicle 4 ___APC___
Vehicle 5 ___TNK___
Vehicle 6 ___JP___
Vehicle 7 ___GG___

Facilitator: Replay this convoy (027-035). Answer any questions before continuing.

Now you will be given four Bn's of convoys to monitor using both the Intermittent Sensor and Continuous Sensor. Each Bn will have five convoys. One Target Log is all you need to record your answers for both Bn's.

CONVOY SOUND RECOGNITION TRAINING
(50 - 2000 Hz Response)

(002) PART I--INTERMITTENT SOUND - VOICE FEEDBACK

Facilitator: Before starting, give each soldier a fresh Target Log.

Step 1 - (003) Instructions on Tape - You will now participate in a training program designed to increase your ability to recognize the individual vehicles in convoys. Aggressor vehicles in convoy are expected to travel close together (about 30 to 50 meters apart) at speeds of 20 - 40 kph depending upon such considerations as visibility and road conditions. Also, they are expected to average about 10 vehicles per convoy. Let us assume that you are monitoring an acoustic sensor that is commanded to listen to each vehicle for four seconds in such a convoy. Given the separation distance and speed of this convoy, the vehicles would be about 4 to 8 or 10 seconds apart with an average separation time of 6 seconds. If your acoustic sensor is on for four seconds, then there will be gaps of dead time between the vehicles. These dead times will help you to know how many vehicles are in each convoy.

You will now hear two Bn convoys. These convoys will be traveling around 40 kph which is about 24 mph. Record your answers on your Target Log. Take your Target Log now and fill in just your name and the date. I'll wait while you do this.

(021) Facilitator: Stop tape and begin when everyone is ready.

Keep in mind what has just been discussed, and see how many vehicles you can recognize. Remember to record your answers with an "X" on your Target Log and start with Convoy 1 on the left-hand side.

Step 2 - (027) Playback - Play convoys 1 (027-035) and 2 (1035-048) (4 sec condition).

Step 3 - Feedback on Tape - OK, let's see how you did. You should have
(049) gotten 6 vehicles for the first convoy and 8 vehicles for the second convoy. Did anybody get this many? Let's see how you did with the sequence. Now you will be given the answers to both convoys in the proper sequence. However, there is a special task for you to do on your Target Log. As I give you each answer, draw a circle in the proper space with your pencil. Draw the circle for each answer whether you got it right or not. Do this so you can use this information later. Remember, draw a circle in the proper space for each answer that I give you whether you got it right or not. For those that you got right, the circle would surround the "X."

Convoy 1 - Target 1 is a TNK
Target 2 is a TNK
Target 3 is a JP
Target 4 is a APC
Target 5 is a TNK
Target 6 is a GG

Convoy 2 - Target 1 is a GG
Target 2 is a GG
Target 3 is a GG
Target 4 is a JP
Target 5 is a 2½T
Target 6 is a 2½T
Target 7 is a 2½T
Target 8 is a 2½T

Now add the total number of targets you got right and write the total at the bottom of the page.

(073) Facilitator: Stop tape and begin when everyone is ready. We will now take some time to make sure everybody understands the procedure and to answer any questions you might have. Everybody take off his earphones and let's talk for a minute.

(077.5) Facilitator: Stop tape and continue after the discussion. At this point allow the

soldiers to respond to how well they performed and reinforce rapport and interest. Make sure everybody recorded the answers. Point out that if a vehicle was missed it would upset the sequence of the remaining vehicles. If the sequence were adjusted accordingly, the soldier might get more correct. When this is finished, say, "OK, everybody put his earphones back on and let's continue."

Time this portion.

Step 4 - Instructions on Tape with Voice Feedback

(080) Now, we will play convoys 3 and 4. Again, you will record your answers on the Target Log but in the convoy 3 and convoy 4 spaces. This time as you hear the vehicles, you will be told the identity of each vehicle immediately after you hear the sound. When you hear the sound of each vehicle, decide what you think it is and quickly record your answer on the Target Log. The answer will then be given to you. This technique will tell you immediately if your answer is correct or incorrect. This technique will help you learn where you're making your mistakes. Let's try it.

Step 5 - Replay with Voice Feedback

(089) Play convoy 3 and 4 in 4 sec. condition with voice feedback.

(110) "Now take your earphones off and let's make sure everybody understands the procedure."

(112) Facilitator: Stop tape - start when discussion is over.

"OK, let's listen to these convoys again with voice feedback. This time, don't use your pencil, just follow along in your mind and decide what each vehicle is before you are told the answer."

Step 6 - Re-replay with Voice Feedback

(116)

(138) These convoys were played several times to help you to recognize these vehicles when you hear them again in other convoys. Now let's go on.

(142.5) PART II - INTERMITTENT SOUND - PAIRED VEHICLES (40 kph - 24 mph)

Step 1 - Instructions on Tape. In this phase of the training you will be able to compare the fast sound of one type of vehicle immediately with that of another. This technique will help you to remember how each target sounds.

Try to draw from your experience what each vehicle sounds like to you. To some of you, a particular vehicle might sound like a motorboat or a Honda motorcycle, or a Greyhound bus, or perhaps something else. In other words, draw a picture in your mind as to what each vehicle sounds like to you. Before each vehicle pair is presented, you will be told which vehicle is presented first and which vehicle is presented second. You will not use your Target Log for this exercise. You will now hear 22 vehicle pairs.

Step 2 - Playback. Play the vehicle pairs in the fast condition. (156)

Comparison 1 is a	JP	and	GG
Comparison 2 is a	JP	and	2½T
Comparison 3 is a	JP	and	5T
Comparison 4 is a	JP	and	10T
Comparison 5 is a	JP	and	APC
Comparison 6 is a	JP	and	TNK
Comparison 7 is a	GG	and	2½T
Comparison 8 is a	GG	and	5T
Comparison 9 is a	GG	and	10T
Comparison 10 is a	GG	and	APC
Comparison 11 is a	GG	and	TNK
Comparison 12 is a	2½T	and	5T
Comparison 13 is a	2½T	and	10T
Comparison 14 is a	2½T	and	APC
Comparison 15 is a	2½T	and	TNK
Comparison 16 is a	5T	and	10T
Comparison 17 is a	5T	and	APC
Comparison 18 is a	5T	and	TNK
Comparison 19 is a	10T	and	APC
Comparison 20 is a	10T	and	TNK
Comparison 21 is a	APC	and	TNK
Comparison 22 is a	TNK (M60)	and	TNK (Sheridan)

PART III - INTERMITTENT SOUND (with voice feedback) - Convoys 5 and 1

Step 1 - Instructions on Tape. Now you will hear two more convoys - convoy 5
(282.5) of the last Bn and convoy 1 of the next Bn. These convoys will be moving more slowly at about 20 kph which is about the same as 12 mph. Start recording your answers in the left-hand side convoy 5 position and continue to the right-hand side convoy 1 position.

Step 2 - Playback. Play convoy 5(289.5) and new convoy 1 (308) in the 4 sec.
(289.5) condition.

Step 3 - Feedback. Okay, let's check how you did. You should have gotten 8 vehicles for the first convoy and 9 vehicles for the second convoy. Let's see what you missed. Now you will be given the answers to both convoys as before. Remember to draw circles in the proper spaces so you can see where you missed. Convoy 5 is easy. All the vehicles are APC's. I'll wait until you draw your circles.

Facilitator: Stop tape, begin when everybody is ready.

(335.5) Convoy 5 - Target 1 is a APC
Target 2 is a APC
Target 3 is a APC
Target 4 is a APC
Target 5 is a APC
Target 6 is a APC
Target 7 is a APC
Target 8 is a APC

(338.5) Convoy 1 - Target 1 is a TNK
Target 2 is a TNK
Target 3 is a TNK
Target 4 is a TNK
Target 5 is a APC
Target 6 is a APC
Target 7 is a APC
Target 8 is a APC
Target 9 is a APC

Step 4 - Instructions on Tape with Voice Feedback

(345.5) Now we will play convoy 2 and convoy 3. Record your answers on the Target Log in the convoy 2 and convoy 3 spaces. As before, you will be told the identity of each vehicle immediately after you hear the sound. Try to draw your X's before the answers are given. When you miss a target, try to figure out why you missed it. Are you ready? Let's go.

Step 5 - Replay with Voice Feedback

(354) Replay convoy 2 and convoy 3.

(393) Let's listen to these convoys again for more practice. Do not use your pencil this time, just follow along and listen closely.

Step 6 - Replay with Voice Feedback

(436) These convoys were replayed to help you recognize these vehicles when you hear them again. Now let's go on.

438.5 Part IV - INTERMITTENT SOUND-PAIRED VEHICLES (20 kph or 12 mph)

Step 1 - Instructions on Tape. Now you will be given vehicle pairs as before except the vehicle speeds will be slower. This technique will allow you to compare the sound of one type of vehicle with the sound of another type of vehicle. Try to draw a picture in your mind as to what each vehicle sounds like to you. Before each vehicle pair is present you will be told which vehicles are being compared. Do not use your Target Log, just listen closely.

Step 2 - Playback - Play the vehicle pairs in the slow condition.
(448.5)

Comparison 1 is a JP and GG
Comparison 2 is a JP and 2½T
Comparison 3 is a JP and 5T
Comparison 4 is a JP and 10T
Comparison 5 is a JP and APC
Comparison 6 is a JP and TNK
Comparison 7 is a GG and 2½T
Comparison 8 is a GG and 5T
Comparison 9 is a GG and 10T
Comparison 10 is a GG and APC
Comparison 11 is a GG and TNK
Comparison 12 is a 2½T and 5T
Comparison 13 is a 2½T and 10T
Comparison 14 is a 2½T and APC
Comparison 15 is a 2½T and TNK
Comparison 16 is a 5T and 10T
Comparison 17 is a 5T and APC
Comparison 18 is a 5T and TNK
Comparison 19 is a 10T and APC
Comparison 20 is a 10T and TNK
Comparison 21 is a APC and TNK
Comparison 22 is a TNK (M60) and TNK (Sheridan)

(592) PART V - INTERMITTENT SOUND - PRACTICE CONVOYS 1, 2, 3, and 4.

Step 1 - Instructions on Tape - Let's see what you have learned. We will
(594) play four convoys and then you can score yourself. Fill out your name and the date on a new Target Log.

(597) Facilitator: Stop tape until everybody is ready. "Start with convoy 1 on the left-hand side of the Target Log. Listen closely to these four convoys and see how many vehicles you can get."

Step 2 - Play convoys 1 (602.5), 2 (619), 3 (643), and 4 (664).
(602.5)

Step 3 - Feedback and Self-Scoring on tape - O.K., let's see how you
(677) did. Draw your circles as I give you the answers. Ready?

(679) Convoy 1 - Target 1 is a GG
Target 2 is a GG
Target 3 is a GG
Target 4 is a JP
Target 5 is a 2½T
Target 6 is a 2½T
Target 7 is a 2½T
Target 8 is a 2½T

(688) Convoy 2 - Target 1 is a TNK
Target 2 is a TNK
Target 3 is a TNK
Target 4 is a TNK
Target 5 is a APC
Target 6 is a APC
Target 7 is a APC
Target 8 is a APC
Target 9 is a APC

(697) Convoy 3 - Target 1 is a APC
Target 2 is a APC
Target 3 is a APC
Target 4 is a APC
Target 5 is a APC
Target 6 is a APC
Target 7 is a APC
Target 8 is a APC

(699.5) Facilitator: Stop tape and begin when everyone is ready.

(701.5) Convoy 4 - Target 1 is a TNK
Target 2 is a TNK
Target 3 is a JP
Target 4 is a APC
Target 5 is a TNK
Target 6 is a GG

(707) How many vehicles did you get? Add them up now and put the total by your name.

(709) Facilitator: Stop tape until everybody is finished.

(710.5) Now, if you left some vehicles out at the beginning of a convoy, that would really mess you up, right? It would make it look like you missed a lot more vehicles than you actually did. So, I want you to score yourself a different way. Add up the total number of vehicles that you got in each target category. Add up the total number of jeeps, gamma goats, 2½T, etc. Record the totals at the bottom of your Target Log.

(721) Facilitator: Stop tape until everybody is ready.

(723.5) Ground truth says there are __2__ JP, __4__ GG, __4__ 2½T, __0__ 5T, __0__ 10T, __14__ APC, and __7__ TNK. If you got a perfect score you are quite exceptional. All right, this finishes this phase of the training. Leave your Target Logs on your desk and we'll take a 15-minute break.

(734) Facilitator: Stop tape, take the break and resume with the continuous convoy sound recognition section of the training.

(737) CONVOY SOUND RECOGNITION TRAINING

(50 - 2000 Hz Response)

(739) PART I - CONTINUOUS SOUND (With CPA feedback) - Convoys 1 and 2

Facilitator: Before starting give each soldier a fresh Target Log.

Step 1 - (741) Instructions on Tape - You will now participate in a training program designed to increase your ability to recognize the individual vehicles in convoys. Aggressor vehicles in convoy are expected to travel close together or about 30 meters to 50 meters apart at speeds of 20 - 40 kph, depending upon visibility and road conditions. Let us assume that you are monitoring an acoustic sensor that is commanded to collect continuous sound for such convoys. What this means is that you will only have about 6 seconds on the average to identify any one vehicle within such a convoy. Because convoys tend to bunch-up and spread-out, you may have only 4 seconds or up to 8 seconds or more to listen to the sound of any one vehicle. However, you may have more time to identify the first and last vehicle. For example, you may hear the first vehicle in the distance as the sound gets louder and louder so naturally you would have more time to identify the first vehicle. In a similar way, you may have more time to identify the last vehicle as the sound trails off. However, the fact remains that you will not have much time to identify the vehicles within the convoy. Again, you will only have about 6 seconds or less depending upon how much the sound of one vehicle is interfering or masking the sound of another vehicle.

Another point to keep in mind is to use the above information in reverse. That is, since you know that the aggressor vehicles are only about 6 seconds apart, you can conclude that you should be recognizing a different vehicle about every 6 seconds.

You will now hear two convoys - one composed of wheeled vehicles and the other composed of both wheeled and tracked vehicles. These convoys are traveling around 40 kph which is about 24mph. Keep in mind what has just been discussed and see how many vehicles you can detect and recognize. Take your Target Log now and fill out your name. I'll wait until you do this.

(792) Facilitator: Stop tape - start when everybody is ready. Okay, is everybody ready? Remember to record your answers with an "X" on your Target Log and start with Convoy 1 on the left-hand side.

Step 2 - Playback - Play Convoys 1 (800) and 2 (821). Continuous sound condition.

Step 3 - Feedback on Tape - Okay, how did you do? Did everyone get 9 vehicles
(844) for the first convoy and 8 vehicles for the second convoy? Now you will be given the answers to both convoys in the proper sequence. However, there is a special task for you to do on your Target Log. As you are given each answer, draw a circle in the proper space with your pencil. Draw the circle for each answer whether you got it right or not! Do this so you can use thisinformation later. OK? Remember now, draw a circle in the proper space for each answer that I give you whether you got it right or not. If you got one right, then the circle would surround the "X."

(858.5) Convoy 1 - Target 1 is a 5T
Target 2 is a TNK
Target 3 is a TNK
Target 4 is a 10T
Target 5 is a JP
Target 6 is a TNK
Target 7 is a JP
Target 8 is a Sheridan TNK
Target 9 is a APC

(872) Convoy 2 - Target 1 is a GG
Target 2 is a GG
Target 3 is a JP
Target 4 is a GG
Target 5 is a 2½T
Target 6 is a 2½T
Target 7 is a 2½T
Target 8 is a 2½T

OK, everybody take off his earphones and let's see how well we did. Also this will be a time to make sure everybody understood the procedure and also to answer any questions.

(890) Facilitator: "Stop tape and have a group check"- At this point allow the soldiers to respond to how they performed and reinforce rapport and interest. Make sure everybody recorded the ground truth answers. Point out the distinctive tone of the Sheridan tank. Answer questions and be responsive to needs of group. When this is finished, say, "OK, everybody put his earphones back on and let's continue."

Step 4 - Instructions for Replay on Tape - Now we will re lay both
(894) convoys so you can listen to the sounds and compare your answers with the ground truth answers that you just recorded. As these convoys are replayed, you will notice that a short tone will signal when each vehicle is closest to the sensor. This point is called the closest point-of-approach or CPA for short. Now we will replay Convoys 1 and 2 with a tone at each vehicle CPA. Remember to follow your Target Log closely. You don't have to make a report - just try to learn to recognize each individual vehicle in your mind.

Step 5 - Replay with CPA on Tape - Replay Convoys 1 (908) and 2 (928.5) with CPS.
(908) with CPA. (951) "Let's listen one more time to this same convoy with the CPA tones. First, however, remove your earphones and let's make sure everybody understands the CPA tone."

(955) Facilitator: Stop Tape for Group Check. Explain again the significance of the CPA tone and how it differs from tape recorder clicks between targets in the continuous mode.

Step 6 - Re-replay with CPA - Re-replay Convoys 1 and 2 with CPA.
(957)

(999) PART II - CONTINUOUS SOUND - PAIRED VEHICLES (40 kph - 24 mph)

Step 1 - Instructions on Tape - In this phase of the training you will be able
(1001) to compare the sound signature of one vehicle immediately with that of another. This technique will help you to remember how each target sounds. Try to draw from your experience what each vehicle sounds like to you. To some of you, a particular vehicle might sound like a motorboat, or a Honda motorcycle, or a Greyhound bus, or perhaps something else. In other words, draw a picture in your mind as to what each vehicle sounds like to you. Before each vehicle pair is presented, you will be told which vehicle is presented first and which vehicle is presented second. You will not use your Target Log for this exercise. You will now hear 22 vehicle pairs.

Step 2 - Playback - Play the vehicle pairs in the fast condition.
(1022.5)

Comparison 1 is a JP and GG
Comparison 2 is a JP and 2½T
Comparison 3 is a JP and 5T
Comparison 4 is a JP and 10T
Comparison 5 is a JP and APC
Comparison 6 is a JP and TNK
Comparison 7 is a GG and 2½T
Comparison 8 is a GG and 5T
Comparison 9 is a GG and 10T
Comparison 10 is a GG and APC
Comparison 11 is a GG and TNK
Comparison 12 is a 2½T and 5T
Comparison 13 is a 2½T and 10T
Comparison 14 is a 2½T and APC
Comparison 15 is a 2½T and TNK
Comparison 16 is a 5T and 10T
Comparison 17 is a 5T and APC
Comparison 18 is a 5T and TNK

Comparison 19 is a 10T and APC

Comparison 20 is a 10T and TNK

Comparison 21 is a APC and TNK

(1247.5) Comparison 22 is a TNK (M60) and TNK (Sheridan)

PART III - CONTINUOUS SOUND (with CPA feedback) - Convoys 3 and 4

Step 1 - Instructions on Tape - Now you will hear convoys three and four. The
(1264) third convoy is traveling slowly at about 20 kph or 12 mph. The fourth convoy is traveling at about 40 kph or 24 mph. Start recording your answers on the Target Log in the convoy 3 position then go to the convoy 4 position. Let's go!

Step 2 - Playback - Play tracked convoy and wheeled convoy continuous
(1279.5) sound condition.

Step 3 - Feedback on Tape - You should have gotten 10 vehicles for
(1343) convoy 3 and 8 vehicles for convoy 4. If you got them all right, you're exceptional. Now you will be given the answers to both convoys as before. Remember to draw circles in the proper spaces so you will have your copy of the answers for later use.

(1356) Convoy 3 - Target 1 is a TNK

Target 2 is a TNK

Target 3 is a TNK

Target 4 is a TNK

Target 5 is a APC

Target 6 is a APC

Target 7 is a APC

Target 8 is a APC

Target 9 is a APC

Target 10 is a APC

(1374) Convoy 4 - Target 1 is a 2½T
Target 2 is a 10T
Target 3 is a 10T
Target 4 is a 2½T
Target 5 is a JP
Target 6 is a JP
Target 7 is a 2½T
Target 8 is a JP

(1390) Facilitator: "Let tape run out and continue on the other side of the tape" (Side 2)

Step 4 - Instructions on Tape for Replay. Now we will replay both convoys so you can
(001) listen to the vehicle sounds and compare your answers with the ground truth answers you have just recorded. As before, a tone will signal the CPA for each vehicle. Do not record information on your Target Log, just follow it closely, especially the vehicles that you missed.

Step 5 - Replay on Tape with CPA - Replay convoys 3 (006) and 4 (024).
(031) To give you more practice we will replay these same two convoys with the CPA tone.

Step 6 - Re-replay with CPA - Re-replay convoys 3 and 4.
(059) Playing these convoys over several times should help you to recognize these vehicles when you hear them again. OK. Let's go on.

(062) PART IV - CONTINUOUS SOUND - PAIRED VEHICLES (20 kph or 12 mph)

Step 1 - Instructions - Now you will be given vehicle pairs as before except
(063.5) the vehicle speeds will be slower. This technique will allow you to compare the slow sound of one type of vehicle with the slow sound of another type of vehicle. Try to draw a picture in your mind as to what each vehicle sounds like to you. Before each vehicle pair is presented, you will be told which vehicles are being compared. Do not use your Target Log, just listen closely.

Step 2 - Playback - Play the vehicle pairs in the slow condition.
(069)

Comparison 1 is a	JP	and	GG
Comparison 2 is a	JP	and	2½T
Comparison 3 is a	JP	and	5T
Comparison 4 is a	JP	and	10T
Comparison 5 is a	JP	and	APC
Comparison 6 is a	JP	and	TNK
Comparison 7 is a	JP	and	2½T
Comparison 8 is a	GG	and	5T
Comparison 9 is a	GG	and	10T
Comparison 10 is a	GG	and	APC
Comparison 11 is a	GG	and	TNK
Comparison 12 is a	2½T	and	5T
Comparison 13 is a	2½T	and	10T
Comparison 14 is a	2½T	and	APC
Comparison 15 is a	2½T	and	TNK
Comparison 16 is a	5T	and	10T
Comparison 17 is a	5T	and	APC
Comparison 18 is a	5T	and	TNK
Comparison 19 is a	10T	and	APC
Comparison 20 is a	10T	and	TNK
Comparison 21 is a	APC	and	TNK
Comparison 22 is a	TNK (M60)	and	TNK (Sheridan)

PART V - CONTINUOUS SOUND - PRACTICE CONVOYS 1, 2, 3, and 4.

Step 1 - Instructions - Now let's see what you have learned. We will play four
(181.5) convoys and then you can score yourself. Start with convoy 1 on the right-hand side of the Target Log. Listen closely and see how well you can do.

Step 2 - Play convoys 1 (185), 2 (204), 3 (212), and 4 (224).
(185)

Step 3 OK, let's see how you did. You will now be given the answers. Draw
(237) your circles as I give you the answers.

(239.5) Convoy 1 - Target 1 is a TNK
Target 2 is a TNK
Target 3 is a TNK
Target 4 is a TNK
Target 5 is a APC
Target 6 is a APC
Target 7 is a APC
Target 8 is a APC
Target 9 is a APC
Target 10 is a APC

(247) Convoy 2 - Target 1 is a 2½T
Target 2 is a 10T
Target 3 is a 10T
Target 4 is a 2½T
Target 5 is a JP
Target 6 is a JP
Target 7 is a 2½T
Target 8 is a JP
Target 9 is a JP

(254.5) Convoy 3 - Target 1 is a GG
Target 2 is a GG
Target 3 is a JP
Target 4 is a GG
Target 5 is a 2½T
Target 6 is a 2½T
Target 7 is a 2½T
Target 8 is a 2½T

(261) Convoy 4 - Target 1 is a 5T
Target 2 is a TNK
Target 3 is a TNK
Target 4 is a 10T
Target 5 is a JP
Target 6 is a TNK
Target 7 is a JP
Target 8 is a Sheridan TNK
Target 9 is a APC

(269.5) How many vehicles did you get right? Add them up by your name. I'll wait while you do this.

(272) Facilitator: Stop tape, start when everyone is ready.

(277.5) Okay let's try a different way of scoring. If you left out some vehicles at the beginning of a convoy, that would really mess you up, right? It might make it look like you missed a lot more than you actually did. So, now I want you to score yourself a different way. Add up the total number of vehicles that you got in each category. In other words, add up the total number of jeeps, gamma goats, 2½ton trucks, etc., and record the totals for each vehicle category at the bottom of your Target Log. I'll wait while you do this.

(287) Facilitator: Stop tape, start when everyone is ready.

(296.5) Ok, is everybody ready? Ground truth says there are 7 JP, 3 GG, 7 2½T, 1 5T, 3 10T, 7 APC, and 8 TNK. If anybody got a perfect score, who are you trying to kid? This completes this portion of the training program.

(300) Facilitator: Stop tape and finish up.

APPENDIX B

PRACTICE EFFECTS

Period effects were significant and appear to indicate a practice effect. However, other considerations argue against it. An analysis of whether practice is involved must consider the possible effects of using scenario A for two successive periods and scenario B for two successive periods (see Table 7). Scenarios were presented either in the continuous or intermittent transmission mode. Familiarity from the first presentation to the next could have been enough to increase period 2 performance. It is possible that if new convoy sounds had been used, the period effect would not have been significant. One way of testing whether a practice effect was operating is to conduct an odd/even analysis within each period. As shown in Table B-1, each period is composed of two battalions of five convoys each. If the odd battalions result in a greater or equal performance compared to the even battalions, then it is unlikely that a practice effect has occurred assuming that the battalions are equal in difficulty. Table B-1 shows an odd/even analysis performed on the pre/post data of the 7-target case.

As indicated by the overall total identifications for the pretest, posttest, and combined results, identification in the even battalions total less than in odd battalions, suggesting that a practice effect did not occur. However, it should be noted that the individual battalion results indicate that there is a consistent increase in performance for the second presentation of the same battalion. Even though the odd/even overall totals suggest that no practice effect occurred, the fact that the second replication of each battalion led consistently to higher scores suggests that a practice effect specific to the vehicles in a convoy did occur. That is, there is no evidence that this transferred to different convoys. Also, this effect should have been transitory in nature and have largely disappeared when the next scenario was given. Learning specific to repeated administrations of scenario A should have dissipated upon administration of scenario B. Thus, little or none of this practice effect would be carried over to the posttest presentation of scenario A. Similarly, the special training given also would tend to dissipate practice effects specific to the particular vehicles of a scenario. Although a practice effect may have occurred, its effects are minimal compared to the pre/posttest comparison of the effects of training.

Further evidence concerning the lack of practice effects was obtained in an experiment concerning signal/noise ratio (to be reported separately). Four levels of signal/noise ratio, four groups of operators, four periods (practice effects), and four scenarios were investigated using a greco-latin square design. The same convoys as in the present study were used with the addition of several new convoys obtained from the same basic maneuver convoy data. The mean identification percentages for each successive period are presented in Table B-2. The analysis of variance results indicated significance differences at the .01 level for period effects. However, this difference was due to the low value of period 2 and not to practice effects.

Table B-1

Odd/Even Analysis of Practice Effect for 7-Target Category

	Scenario A				Scenario B				
	First period		Second period		First period		Second period		Overall
	BN1	BN2	BN1	BN2	BN3	BN4	BN3	BN4	totals
Pretest									
Odd	181		219		227		271		898
Even		216		239		160		178	793
Posttest									
Odd	297		308		339		351		1295
Even		334		348		240		242	1174
Combined									
Odd	478		527		566		622		2193
Even		560		587		400		420	1967

Table B-2

Mean Percent Correct Identification for the 7-Target Category
(Signal/Noise Experiment by Periods)

	Period 1	Period 2	Period 3	Period 4
% Correct	28%	22%	27%	26%

DISTRIBUTION

ARI Distribution List

4 OASD (M&RA)
2 HQDA (DAMI-CSZ)
1 HQDA (DAPE-PBR
1 HQDA (DAMA-AR)
1 HQDA (DAPE-HRE-PO)
1 HQDA (SGRD-ID)
1 HQDA (DAMI-DOT-C)
1 HQDA (DAPC-PMZ-A)
1 HQDA (DACH-PPZ-A)
1 HQDA (DAPE-HRE)
1 HQDA (DAPE-MPO-C)
1 HQDA (DAPE-DW)
1 HQDA (DAPE-HRL)
1 HQDA (DAPE-CPS)
1 HQDA (DAFD-MFA)
1 HQDA (DARD-ARS-P)
1 HQDA (DAPC-PAS-A)
1 HQDA (DUSA-OR)
1 HQDA (DAMO-RQR)
1 HQDA (DASG)
1 HQDA (DA10-PI)
1 Chief, Consult Div (DA-OTSG), Adelphi, MD
1 Mil Asst. Hum Res, ODDR&E, OAD (E&LS)
1 HQ USARAL, APO Seattle, ATTN: ARAGP-R
1 HQ First Army, ATTN: AFKA-OI-TI
2 HQ Fifth Army, Ft Sam Houston
1 Dir, Army Stf Studies Ofc, ATTN: OAVCSA (DSP)
1 Ofc Chief of Stf, Studies Ofc
1 DCSPER, ATTN: CPS/OCP
1 The Army Lib, Pentagon, ATTN: RSB Chief
1 The Army Lib, Pentagon, ATTN: ANRAL
1 Ofc, Asst Sect of the Army (R&D)
1 Tech Support Ofc, OJCS
1 USASA, Arlington, ATTN: IARD-T
1 USA Rsch Ofc, Durham, ATTN: Life Sciences Dir
2 USARIEM, Natick, ATTN: SGRD-UE-CA
1 USATTC, Ft Clayton, ATTN: STETC-MO-A
1 USAIMA, Ft Bragg, ATTN: ATSU-CTD-OM
1 USAIMA, Ft Bragg, ATTN: Marquat Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Tng Dir
1 USA Quartermaster Sch, Ft Lee, ATTN: ATSM-TE
1 Intelligence Material Dev Ofc, EWL, Ft Holabird
1 USA SE Signal Sch, Ft Gordon, ATTN: ATSO-EA
1 USA Chaplain Ctr & Sch, Ft Hamilton, ATTN: ATSC-TE-RD
1 USATSCH, Ft Eustis, ATTN: Educ Advisor
1 USA War College, Carlisle Barracks, ATTN: Lib
2 WRAIR, Neuropsychiatry Div
1 DLI, SDA, Monterey
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-WGC
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-MR
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-JF
1 USA Artic Test Ctr, APO Seattle, ATTN: STEAC-MO-ASL
1 USA Artic Test Ctr, APO Seattle, ATTN: AMSTE-PL-TS
1 USA Armament Cmd, Redstone Arsenal, ATTN: ATSK-TEM
1 USA Armament Cmd, Rock Island, ATTN: AMSAR-TDC
1 FAA-NAFEC, Atlantic City, ATTN: Library
1 FAA-NAFEC, Atlantic City, ATTN: Hum Engr Br
1 FAA Aeronautical Ctr, Oklahoma City, ATTN: AAC-44D
2 USA Fld Arty Sch, Ft Sill, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DI-E
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DT-TP
1 USA Armor Sch, Ft Knox, ATTN: ATSB-CD-AD
2 HQUSACDEC, Ft Ord, ATTN: Library
1 HQUSACDEC, Ft Ord, ATTN: ATEC-EX-E-Hum Factors
2 USAEEC, Ft Benjamin Harrison, ATTN: Library
1 USAPACDC, Ft Benjamin Harrison, ATTN: ATCP-HR
1 USA Comm-Elect Sch, Ft Monmouth, ATTN: ATSN-EA
1 USAEC, Ft Monmouth, ATTN: AMSEL-CT-HDP
1 USAEC, Ft Monmouth, ATTN: AMSEL-PA-P
1 USAEC, Ft Monmouth, ATTN: AMSEL-SI-CB
1 USAEC, Ft Monmouth, ATTN: C, Facl Dev Br
1 USA Materials Sys Anal Agcy, Aberdeen, ATTN: AMXSY-P
1 Edgewood Arsenal, Aberdeen, ATTN: SAREA-BL-H
1 USA Ord Ctr & Sch, Aberdeen, ATTN: ATSL-TEM-C
2 USA Hum Engr Lab, Aberdeen, ATTN: Library/Dir
1 USA Combat Arms Tng Bd, Ft Benning, ATTN: Ad Supervisor
1 USA Infantry Hum Rsch Unit, Ft Benning, ATTN: Chief
1 USA Infantry Bd, Ft Benning, ATTN: STEBC-TE-T
1 USASMA, Ft Bliss, ATTN: ATSS-LRC
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA-CTD-ME
1 USA Air Def Sch, Ft Bliss, ATTN: Tech Lib
1 USA Air Def Bd, Ft Bliss, ATTN: FILES
1 USA Air Def Bd, Ft Bliss, ATTN: STEBD-PO
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Lib
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: ATSW-SE-L
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Ed Advisor
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: DepCdr
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: CCS
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCASA
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACO-E
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACC-CI
1 USAECOM, Night Vision Lab, Ft Belvoir, ATTN: AMSEL-NV-SD
3 USA Computer Sys Cmd, Ft Belvoir, ATTN: Tech Library
1 USAMERDC, Ft Belvoir, ATTN: STSFB-DQ
1 USA Eng Sch, Ft Belvoir, ATTN: Library
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-TD-S
1 USA Topographic Lab, Ft Belvoir, ATTN: STINFO Center
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-GSL
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATS-CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TE
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEX-GS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTS-OR
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-DT
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-CS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: DAS/SRD
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEM
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: Library
1 CDR, HQ Ft Huachuca, ATTN: Tech Ref Div
2 CDR, USA Electronic Prvg Grd, ATTN: STEEP-MT-S
1 CDR, Project MASSTER, ATTN: Tech Info Center
1 Hq MASSTER, USATRADOC, LNO
1 Research Institute, HQ MASSTER, Ft Hood
1 USA Recruiting Cmd, Ft Sherdian, ATTN: USARCPM-P
1 Senior Army Adv, USAFAGOD/TAC, Elgin AF Aux Fld No. 9
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1 Marine Corps Inst., ATTN: Dean-MCI
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2 USCG Academy, New London, ATTN: Admission
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1 USCG Training Ctr, NY, ATTN: CO
1 USCG Training Ctr, NY, ATTN: Educ Svc Ofc
1 USCG, Psychol Res Br, DC, ATTN: GP 1/62
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1 US Marine Corps Liaison Ofc, AMC, Alexandria, ATTN: AMCGS-F
1 USATRADOC, Ft Monroe, ATTN: ATRO-ED
6 USATRADOC, Ft Monroe, ATTN: ATPR-AD
1 USATRADOC, Ft Monroe, ATTN: ATTS-EA
1 USA Forces Cmd, Ft McPherson, ATTN: Library
2 USA Aviation Test Bd, Ft Rucker, ATTN: STEBG-PO
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Library
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Educ Advisor
1 USA Aviation Sch, Ft Rucker, ATTN: PO Drawer O
1 HQUSA Aviation Sys Cmd, St Louis, ATTN: AMSAV-ZDR
2 USA Aviation Sys Test Act., Edwards AFB, ATTN: SAVTE-T
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA TEM
1 USA Air Mobility Rsch & Dev Lab, Moffett Fld, ATTN: SAVDL-AS
1 USA Aviation Sch, Res Tng Mgt, Ft Rucker, ATTN: ATST-T-RTM
1 USA Aviation Sch, CO, Ft Rucker, ATTN: ATST-D-A
1 HQ, DARCOM, Alexandria, ATTN: AMXCD-TL
1 HQ, DARCOM, Alexandria, ATTN: CDR
1 US Military Academy, West Point, ATTN: Serials Unit
1 US Military Academy, West Point, ATTN: Ofc of Milt Ldrshp
1 US Military Academy, West Point, ATTN: MAOR
1 USA Standardization Gp, UK, FPO NY, ATTN: MASE-GC
1 Ofc of Naval Rsch, Arlington, ATTN: Code 452
3 Ofc of Naval Rsch, Arlington, ATTN: Code 458
1 Ofc of Naval Rsch, Arlington, ATTN: Code 450
1 Ofc of Naval Rsch, Arlington, ATTN: Code 441
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Acous Sch Div
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L51
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L5
1 Chief of NavPers, ATTN: Pers-OR
1 NAVAIRSTA, Norfolk, ATTN: Safety Ctr
1 Nav Oceanographic, DC, ATTN: Code 6251, Charts & Tech
1 Center of Naval Anal, ATTN: Doc Ctr
1 NavAirSysCom, ATTN: AIR-5313C
1 Nav BuMed, ATTN: 713
1 NavHelicopterSubSqua 2, FPO SF 96601
1 AFHRL (FT) Williams AFB
1 AFHRL (TT) Lowry AFB
1 AFHRL (AS) WPAFB, OH
2 AFHRL (DOJZ) Brooks AFB
1 AFHRL (DOJN) Lackland AFB
1 HQUSAF (INYSD)
1 HQUSAF (DPXXA)
1 AFVTG (RD) Randolph AFB
3 AMRL (HE) WPAFB, OH
2 AF Inst of Tech, WPAFB, OH, ATTN: ENE/SL
1 ATC (XPTD) Randolph AFB
1 USAF AeroMed Lib, Brooks AFB (SUL-4), ATTN: DOC SEC
1 AFOSR (NL), Arlington
1 AF Log Cmd, McClellan AFB, ATTN: ALC/DPCRB
1 Air Force Academy, CO, ATTN: Dept of Bel Scn
5 NavPers & Dev Ctr, San Diego
2 Navy Med Neuropsychiatric Rsch Unit, San Diego
1 Nav Electronic Lab, San Diego, ATTN: Res Lab
1 Nav TrngCen, San Diego, ATTN: Code 9000-Lib
1 NavPostGraSch, Monterey, ATTN: Code 55As
1 NavPostGraSch, Monterey, ATTN: Code 2124
1 NavTrngEquipCtr, Orlando, ATTN: Tech Lib
1 US Dept of Labor, DC, ATTN: Manpower Admin
1 US Dept of Justice, DC, ATTN: Drug Enforce Admin
1 Nat Bur of Standards, DC, ATTN: Computer Info Section
1 Nat Clearing House for MH-Info, Rockville
1 Denver Federal Ctr, Lakewood, ATTN: BLM
12 Defense Documentation Center
4 Dir Psych, Army Hq, Russell Ofcs, Canberra
1 Scientific Advsr, Mil Bd, Army Hq, Russell Ofcs, Canberra
1 Mil and Air Attache, Austrian Embassy
1 Centre de Recherche Des Facteurs, Humaine de la Defense Nationale, Brussels
2 Canadian Joint Staff Washington
1 C/Air Staff, Royal Canadian AF, ATTN: Pers Std Anal Br
3 Chief, Canadian Def Rsch Staff, ATTN: C/CRDS(W)
4 British Def Staff, British Embassy, Washington
1 Def & Civil Inst of Enviro Medicine, Canada
1 AIR CREW, Kensington, ATTN: Info Sys Br
1 Militaerpsykologisk Tjeneste, Copenhagen
1 Military Attache, French Embassy, ATTN: Doc Sec
1 Medecin Chef, C.E.R.P.A.-Arsenal, Toulon/Naval France
1 Prin Scientific Off, Appl Hum Engr Rsch Div, Ministry of Defense, New Delhi
1 Pers Rsch Ofc Library, AKA, Israel Defense Forces
1 Ministerie van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands